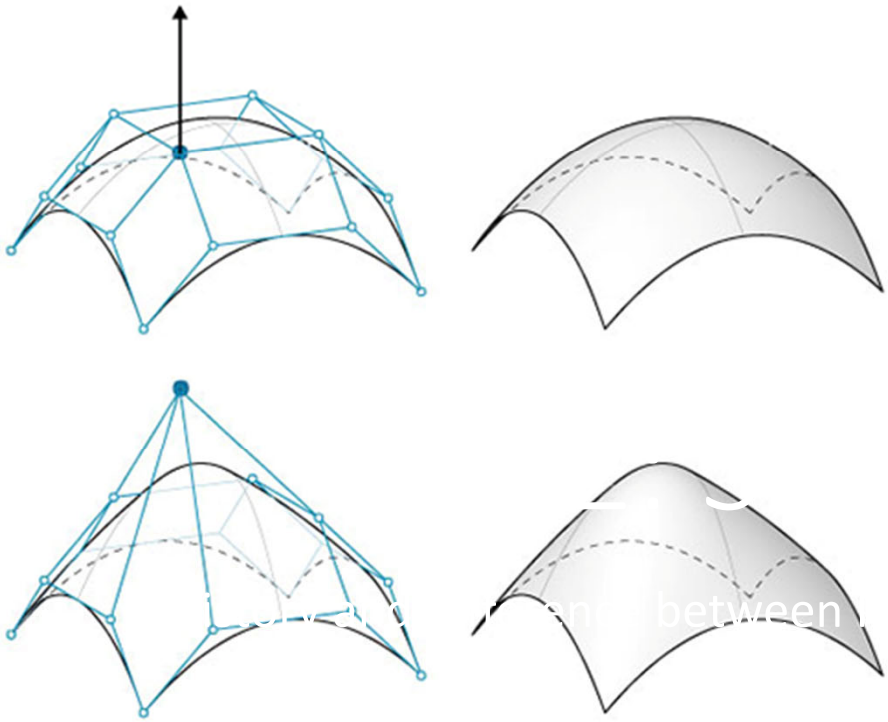
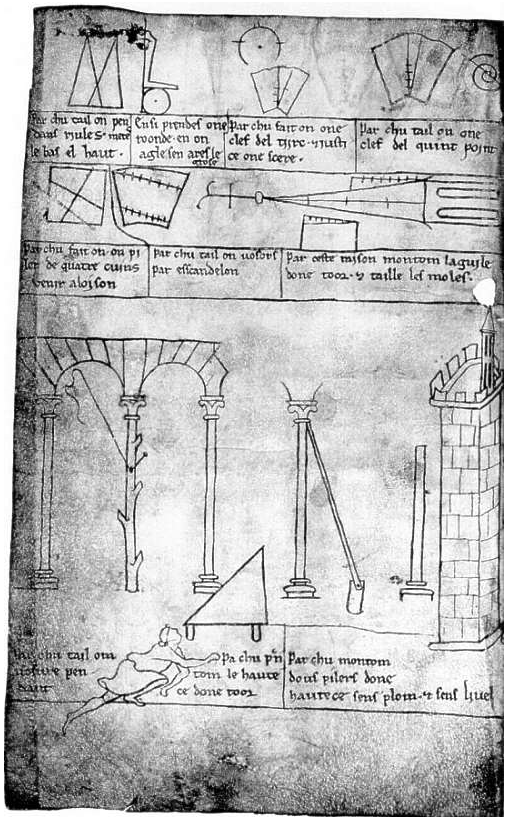


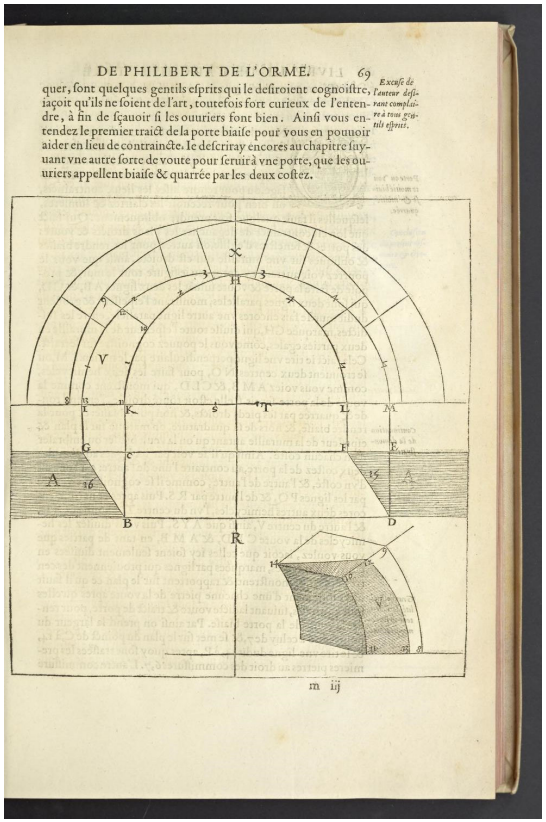
Content

- Short history of drafting (Interesting to know)
- NURBS and Mesh(Good to know)
- Parametric Curve (Good to know)
- Repetition Vectors (Important to know)

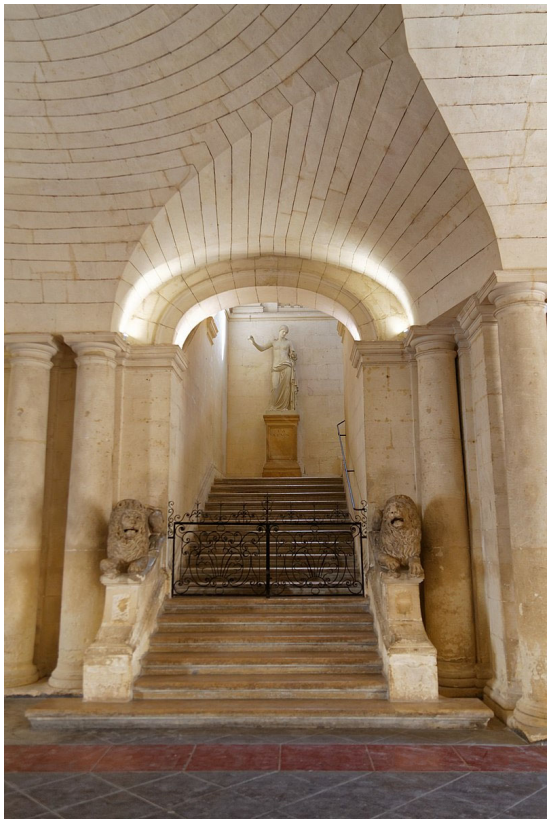
Stereotomy – The art of cutting stones



Villard de Honnecourt – Sketchbook, 13th century, Public Domain, https://commons.wikimedia.org/w/index.php?curid=435006

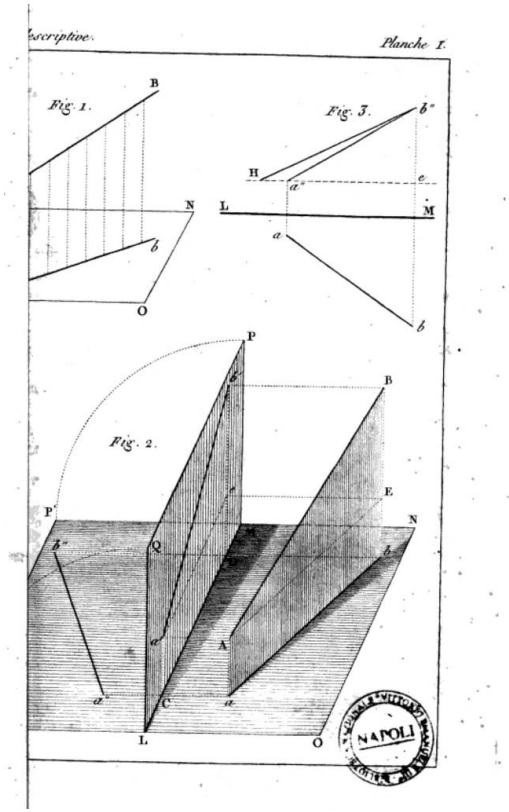


Delorme, P. (1567). *Le Premier tome de l'Architecture de Philibert de L'Orme ...* http://www.mdz-nbn-resolving.de/urn/resolver.pl?urn=urn:nbn:de:bvb:12-bsb10195337-1

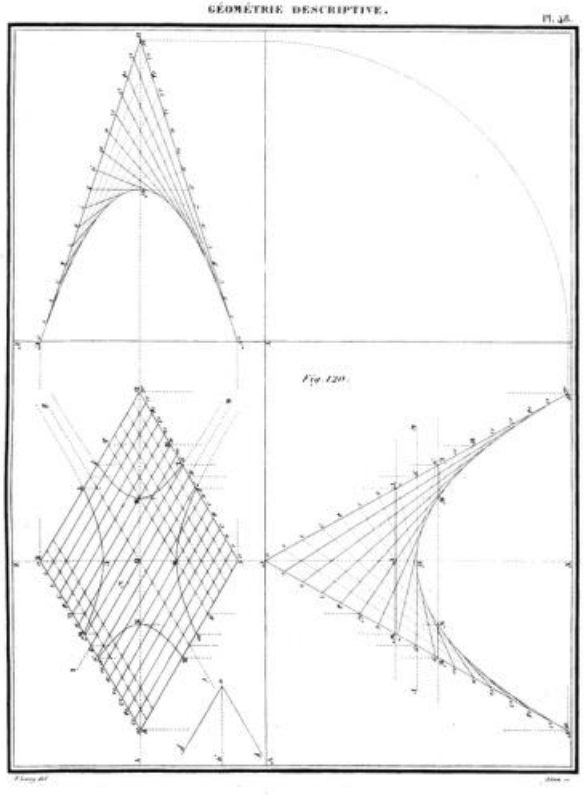


Hotel de Ville, 1676, Jacques Peytret et Jules Hardouin-Mansart , Arles. Photo By Bjs - Own work, CC BY-SA 4.0, https://commons.wikimedia.org/w/index.php?curid=73970693

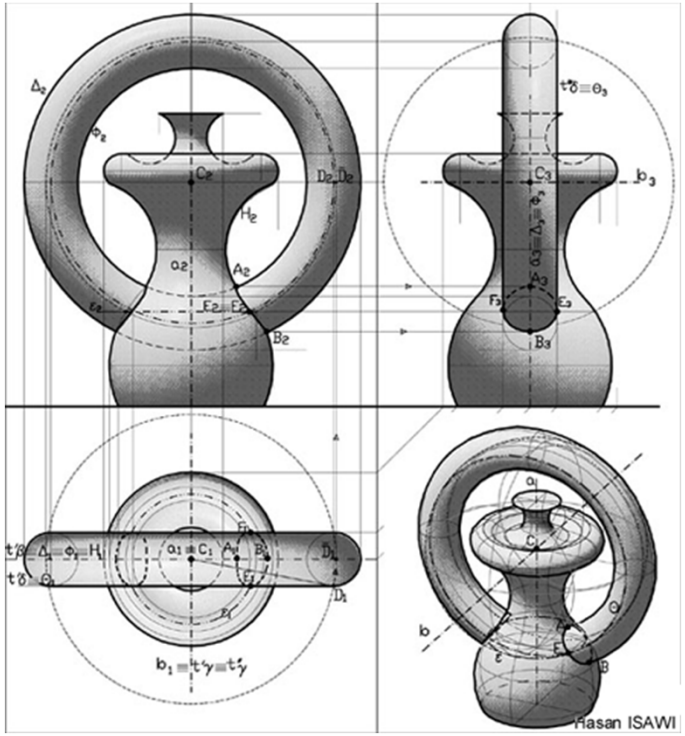
Gaspard Monge – the birth of engineering drawing.



Monge, G. (1798). Géométrie descriptive. Baudouin. https://doi.org/10.3931/e-rara-4796

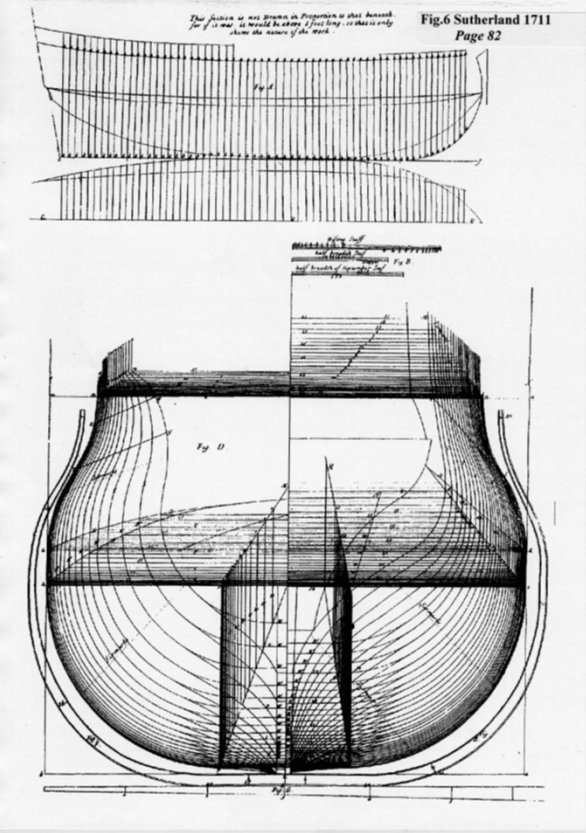


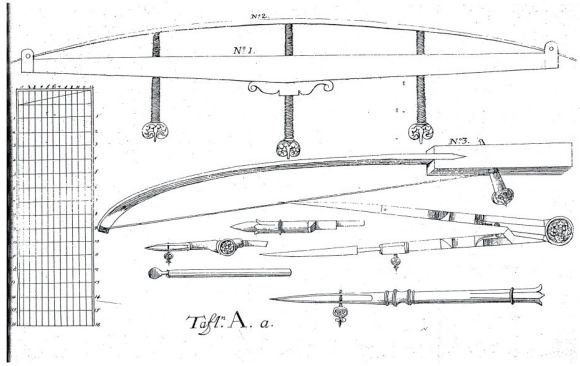
Traité de géométrie descriptive avec une collection d'épures, composée de 60 planches par C.F.A. Leroy.(1834)



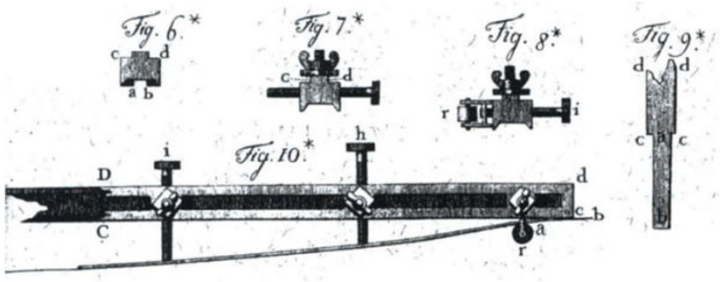
By Hasanisawi - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=2859643

The Spline – Flexible curve for drafting





Raalamb, Aake Classon: “Skepps Byggeriet eller Adelig Öfning”, Tionde Tom, Stockholm, 1691.



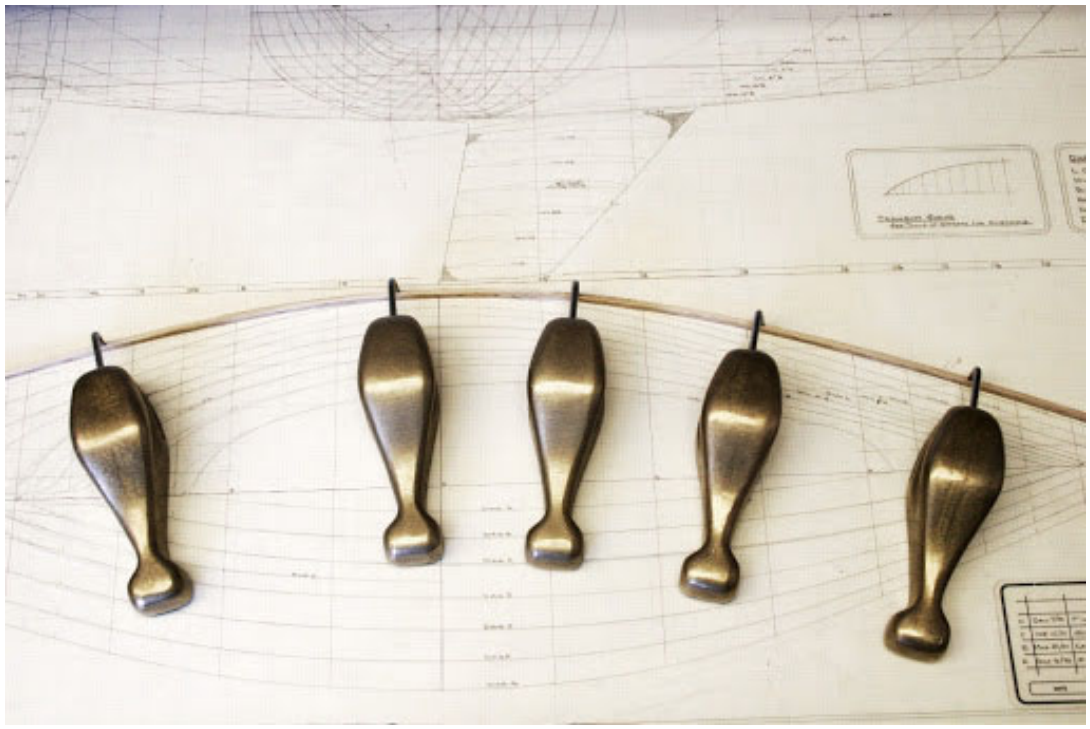
Splines: a mechanical spline from the 1700s, from
Farin, G. (2002). A History of Curves and Surfaces in CAGD. In *Handbook of Computer Aided Geometric Design*. https://doi.org/10.1016/b978-044451104-1/50002-2

The Spline – Flexible curve for drafting

Boeing draftman. Courtesy of Boeing.

By Hasanisawi - Own work, CC BY-SA 3.0,
https://commons.wikimedia.org/w/index.php?curid=2859643

The Spline – Flexible curve for drafting

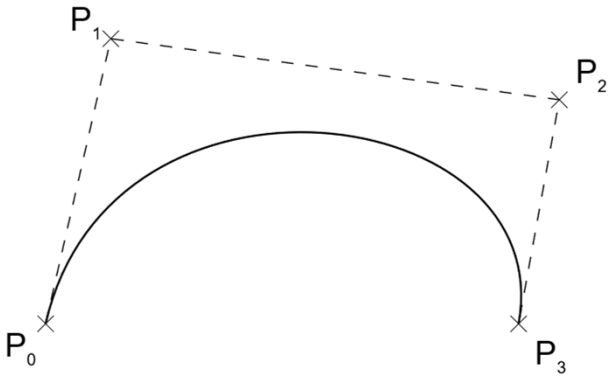


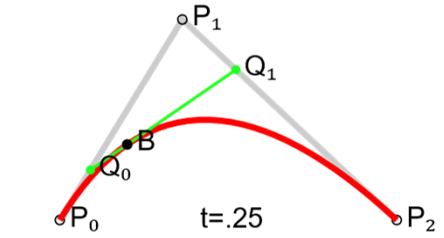
Boeing draftman. Courtesy of Boeing.

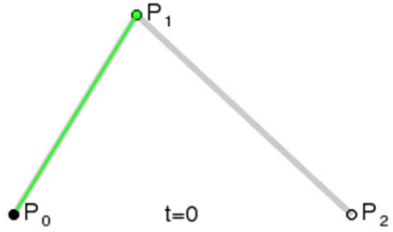
Bezier Curve

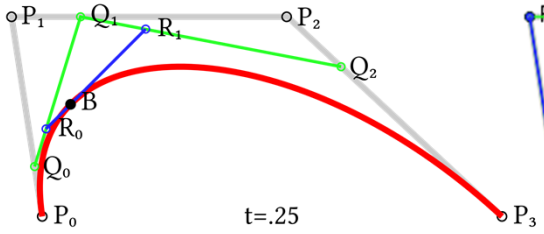
Developed for use in the automotive industry around 1960. Was developed simultaneously at by Pierre Bézier and Paul de Casteljau. Beziér working for Citroén Casteljau for Renault.

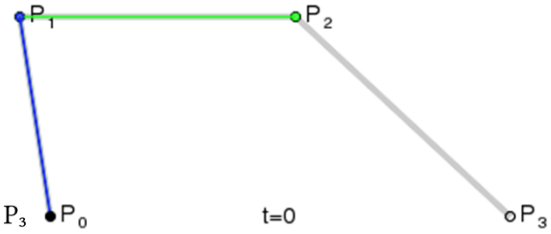
$$\mathbf{B}(t) = \sum_{j=0}^{n} t^j \mathbf{C}_j$$











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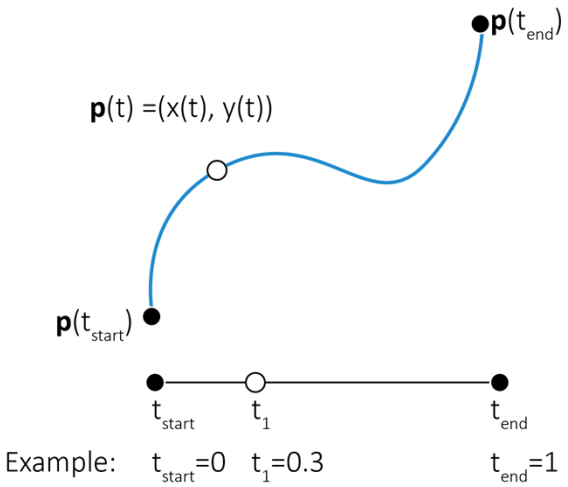
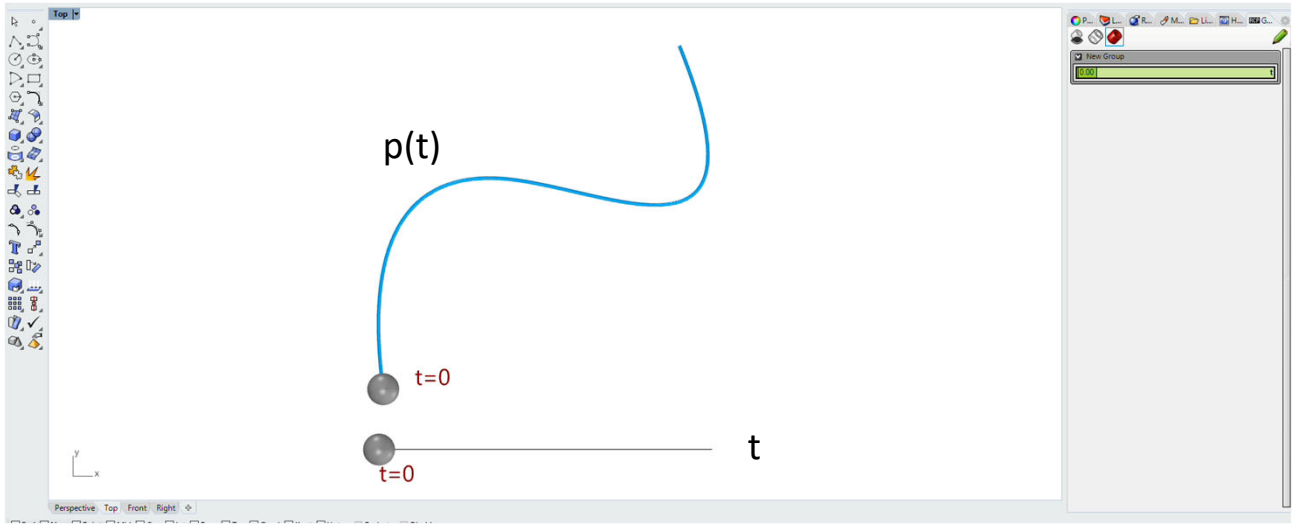
Parametric curves





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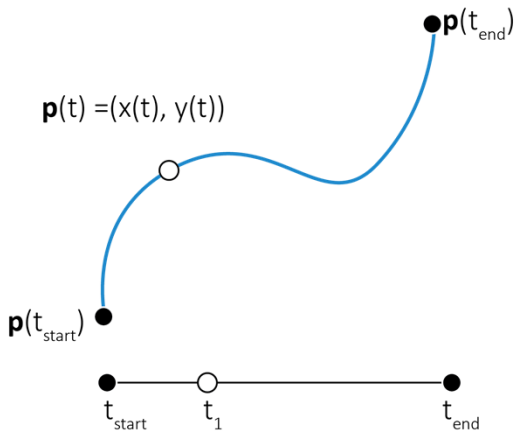
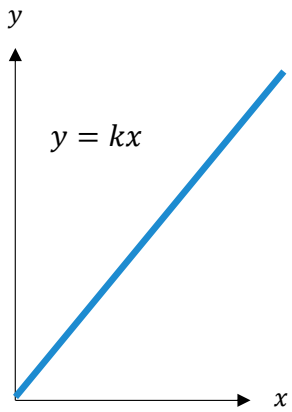
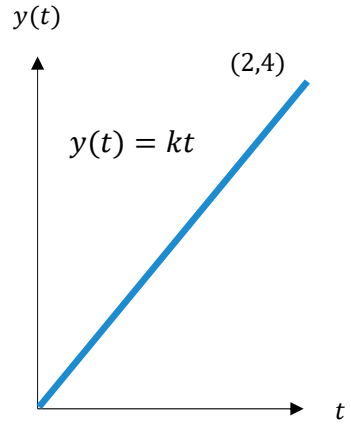
Parametric curves





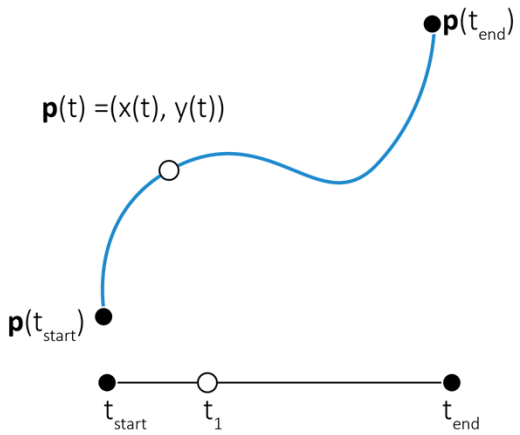
$y = kx$

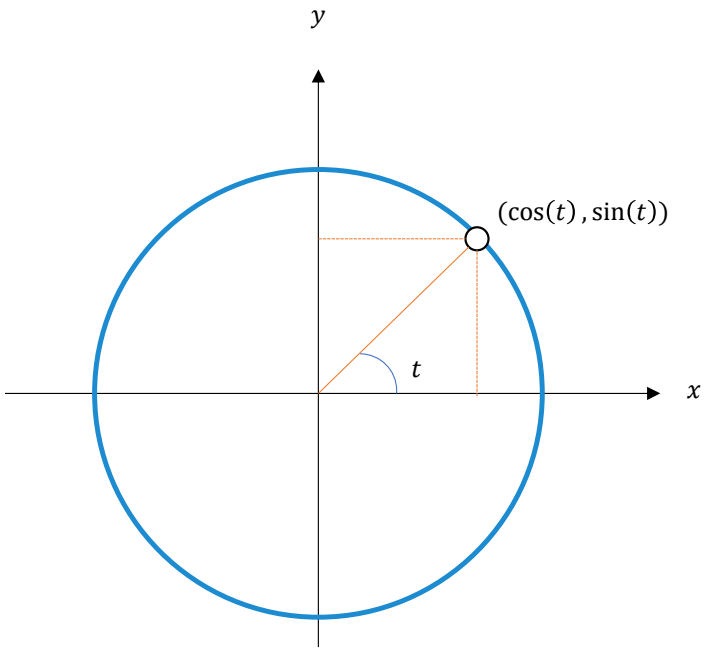


$x(t) = t,$
$y(t) = kt$

Läs mer:
https://www.matteboken.se/lektioner/matte-1/funktioner/linjara-funktioner

Parametric curves

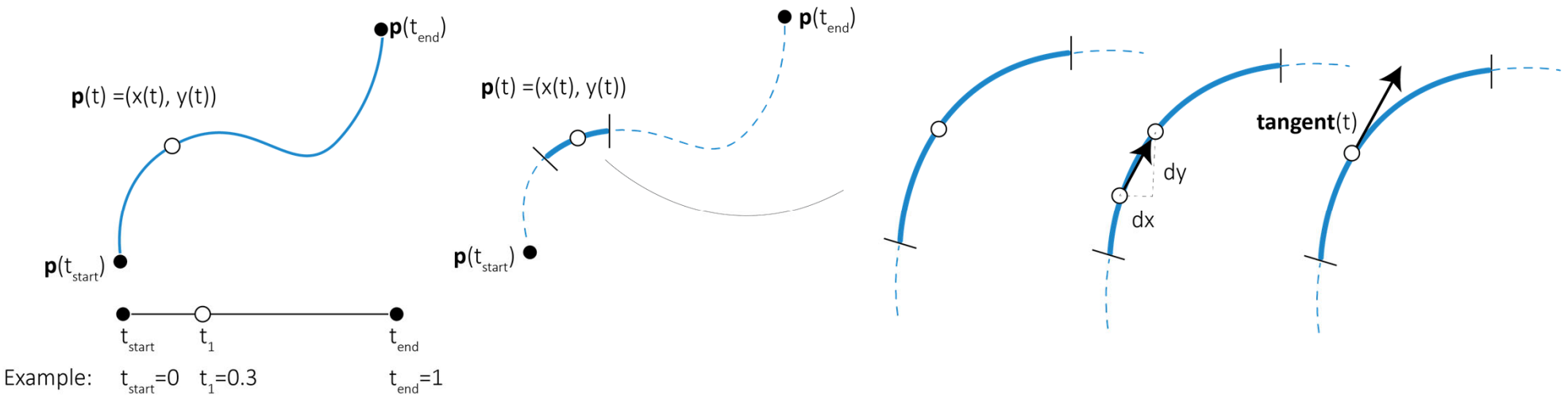




$x(t) = \cos(t),$
$y(t) = \sin(t)$
$0 < t < \pi$
$0 < t < 360$

Läs mer:
https://www.matteboken.se/lektioner/matte-3/trigonometri/enhetscirkeln

Parametric curves - Tangent



https://www.matteboken.se/lektioner/matte-3/derivata/derivata

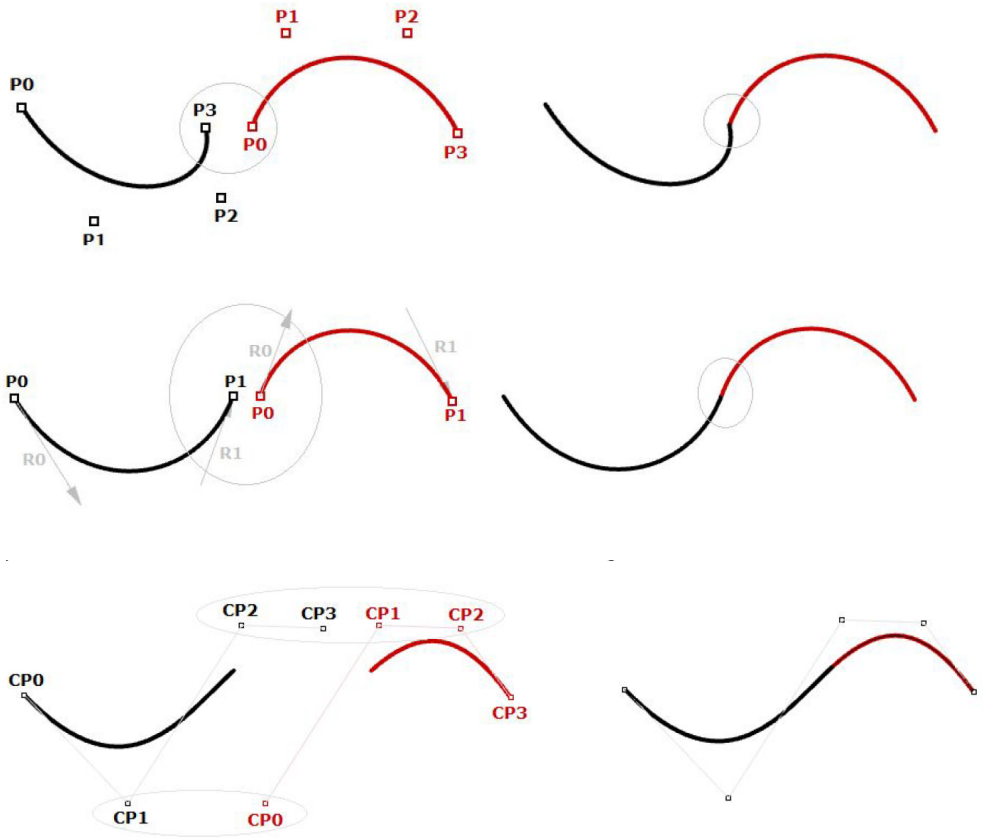
Bezier Curve -> Non-uniform rational B-spline (NURBS)

Two Bezier segments – Share same point

Two Hermite curve segments
– Share same point and tangent

NURBS Segments – Share same point, tangent and curvature

Smoothness



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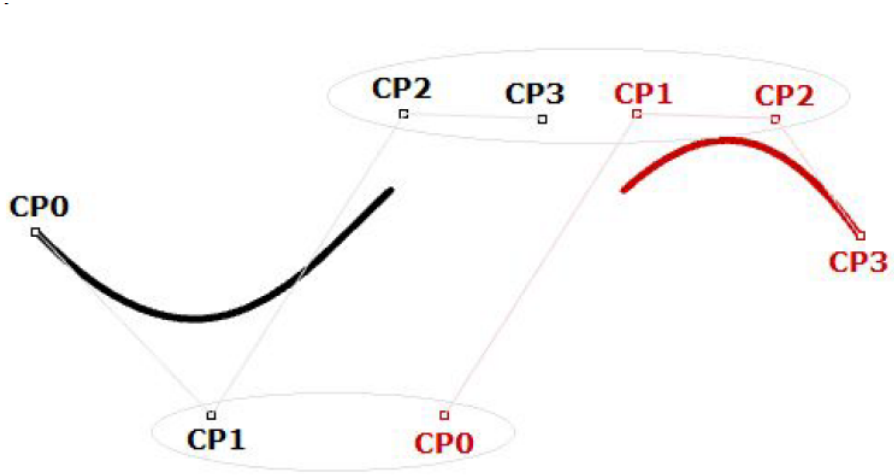
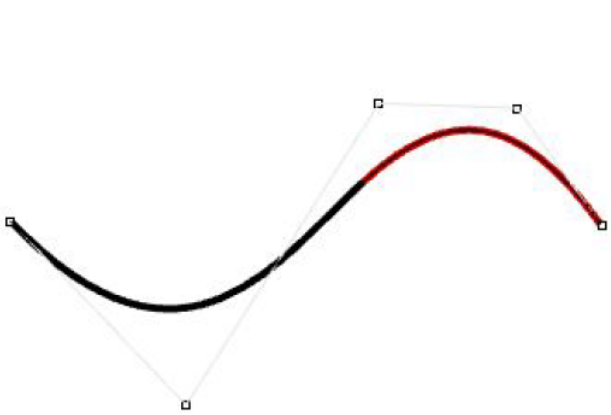
Non-uniform rational B-spline (NURBS)





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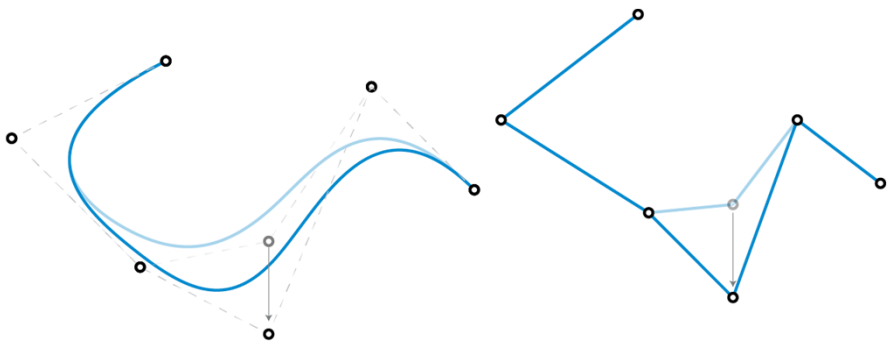
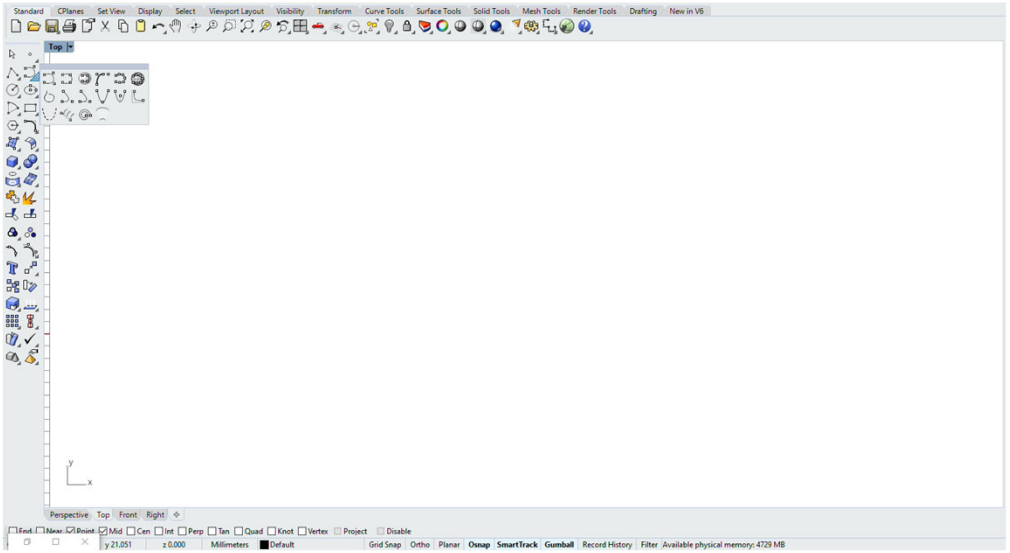
NURBS Curve and Polyline Comparison

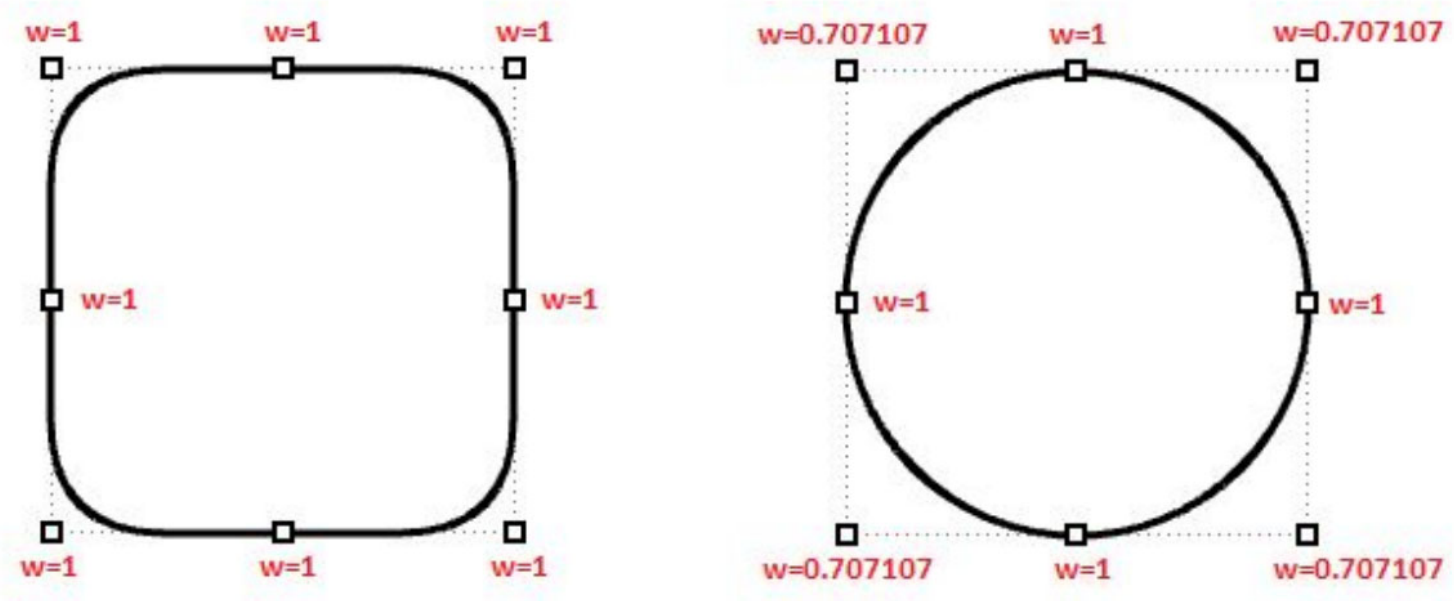


Discrete curve

Smooth curve



NURBS Curve – Weighting



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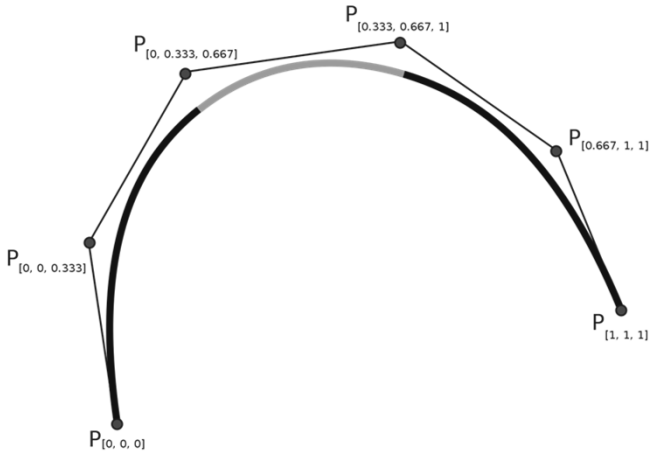
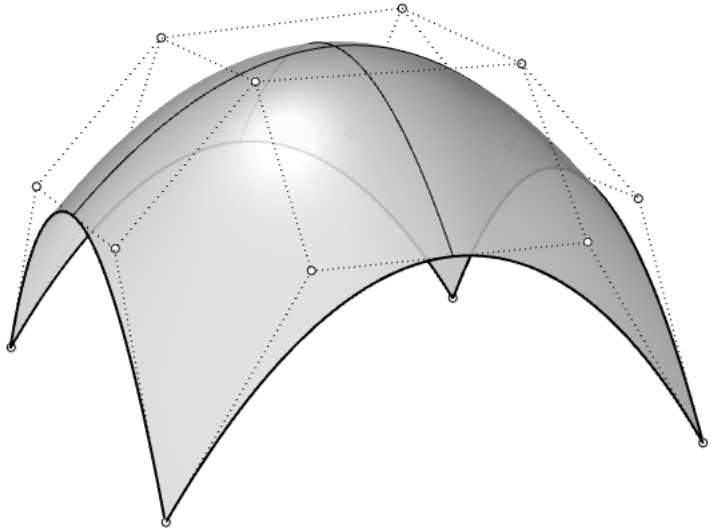
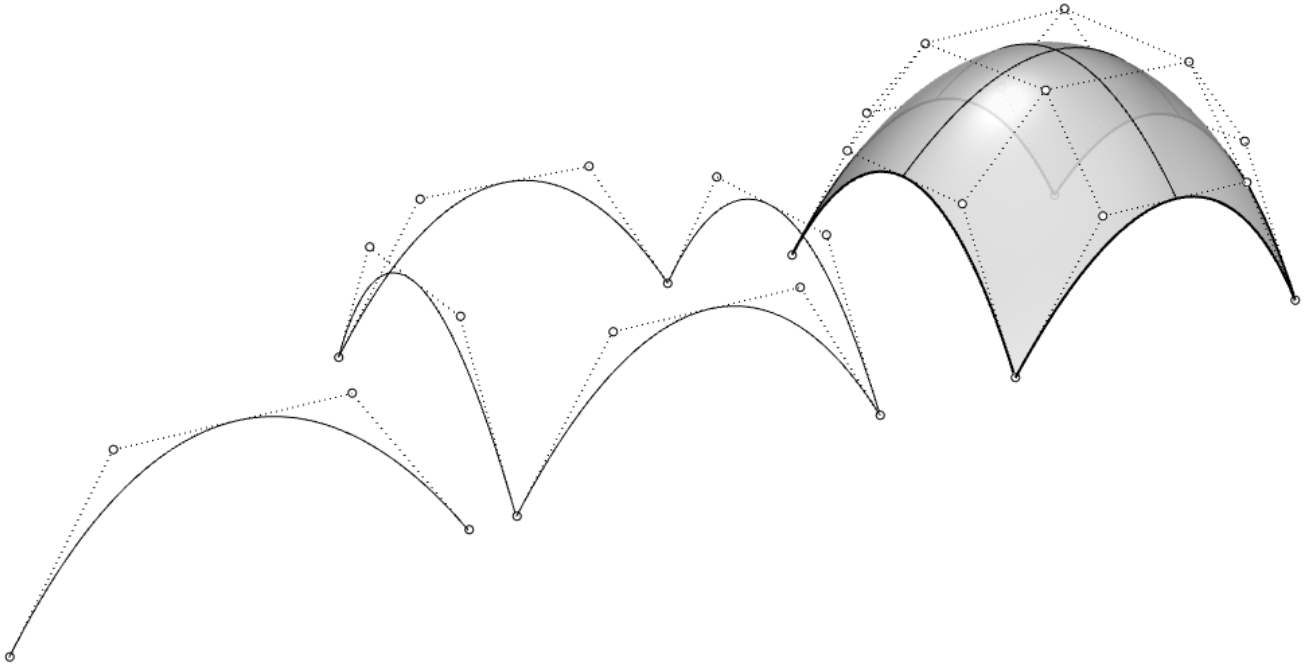
NURBS Surface

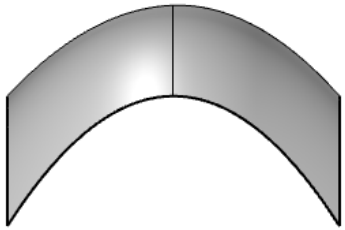




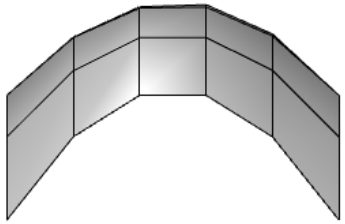
NURBS Surface



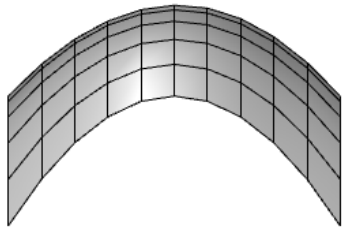
Mesh Surface



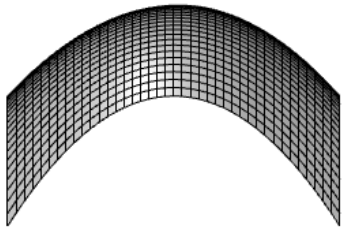
NURBS Surface



Mesh low resolution

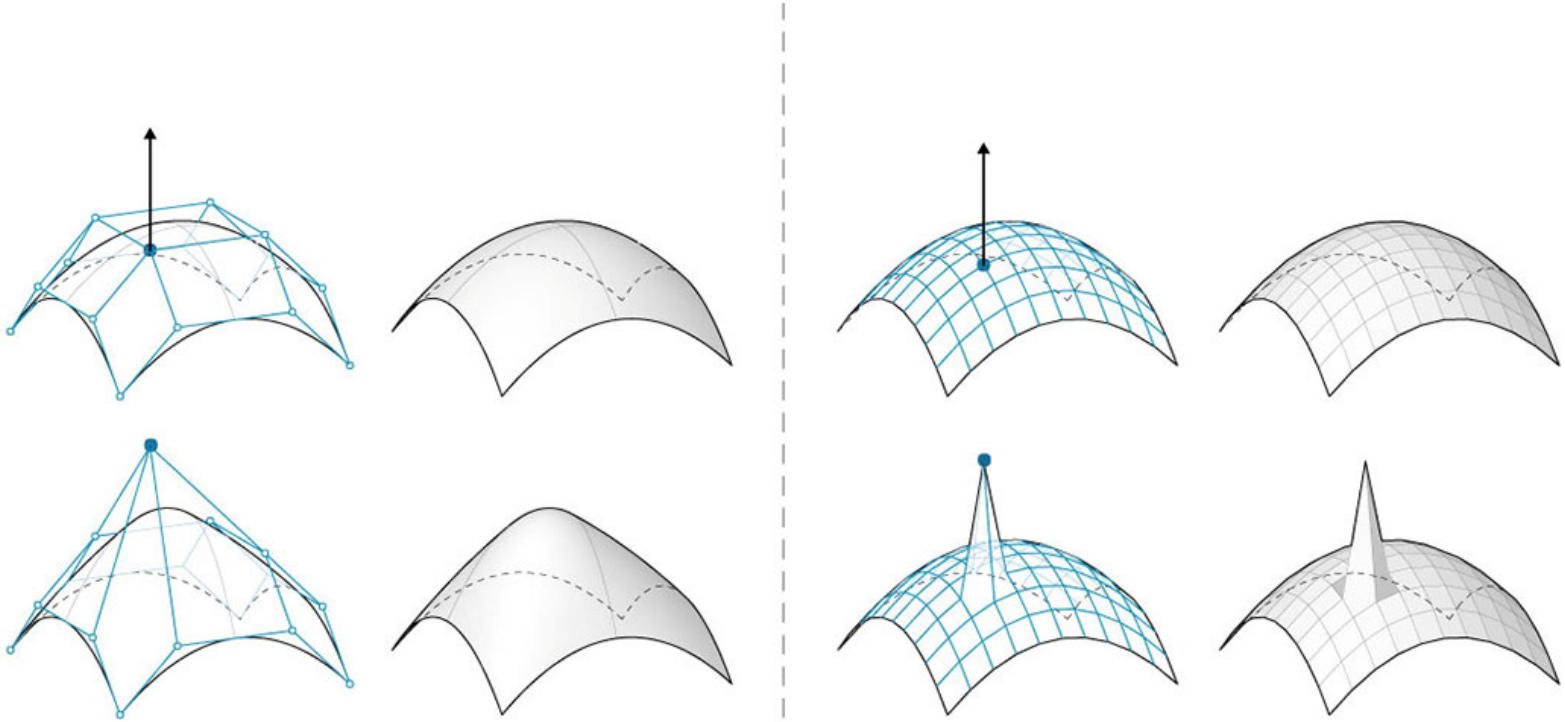


Mesh mid resolution



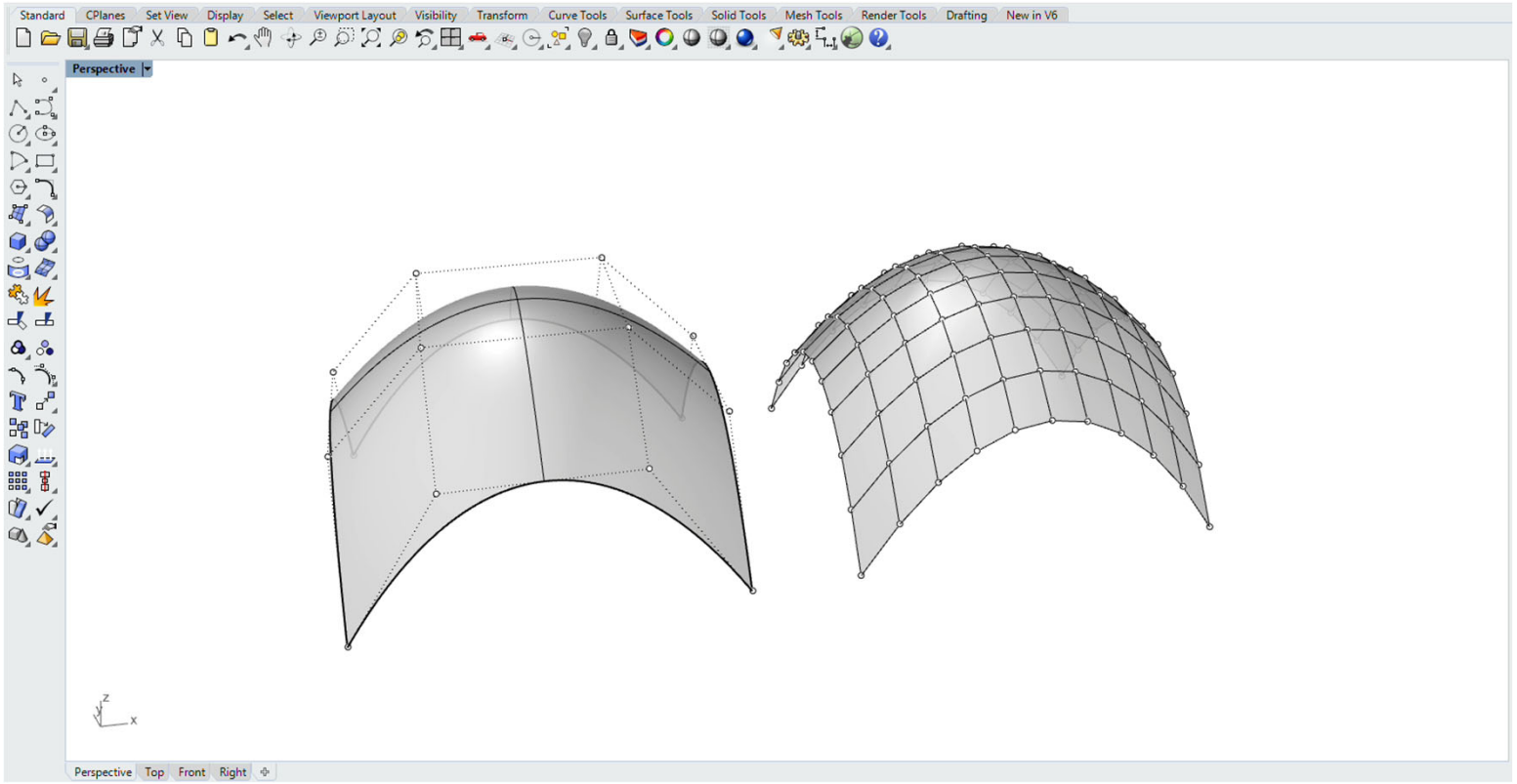
Mesh high resolution

Surface and Mesh Comparison

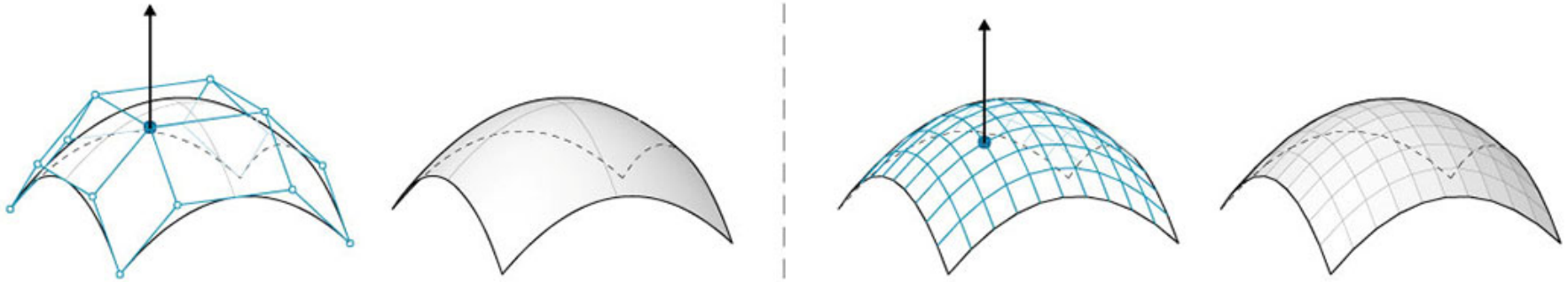


https://primer.dynamobim.org/05_Geometry-for-Computational-Design/5-7_meshes.html

Surface and Mesh Comparison



Surface and mesh comparison



https://primer.dynamobim.org/05_Geometry-for-Computational-Design/5-7_meshes.html

Surface good:
•Analytically defined geometry (it's *smooth* no matter how far you zoom in).
•Small memory/file footprint (you do not need many points to define a curvy surface, however the benefits are somewhat mitigated by the fact that every surface carries around a display mesh used for shading).
•Simple topology (a surface is always a finite uv patch topologically speaking, makes it easier to develop algorithms for them).
•Accuracy (because surfaces are analytical, things like intersections yield accurate results).

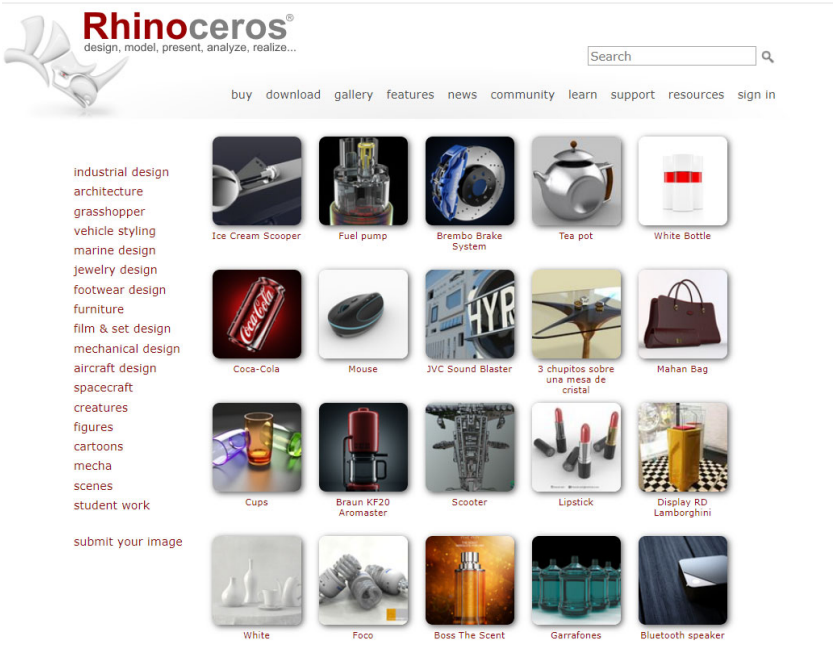
Surface bad:
•The maths involved is difficult.
•It's difficult if not impossible to exchange surface data with other 3D applications.
•Topologically limited (sort of the flip-side of the topological simplicity argument. Sometimes you need a higher genus shape and then a single surface will no longer cut the mustard).

Mesh good:
•Simple definition (points, polygons connecting those points, there done).
•Highly exchangeable with other apps.
•Modern graphics hardware is really good at displaying meshes fast.
•No topological constraints.
•Lots of published research and algorithms for meshes, not so much for nurbs surfaces.
•You can associate specific colours with specific points on the mesh.

Mesh bad:
•It's not smooth, it's discrete.
•It can be really difficult to perform operations on the mesh shape, because there is no intrinsic parameterisation.
•There's lots of ways in which a mesh can be invalid.

David Rutten, Founder of Grasshopper
https://discourse.mcneel.com/t/mesh-or-surface-understanding-the-difference/75151/3

What software’s for what

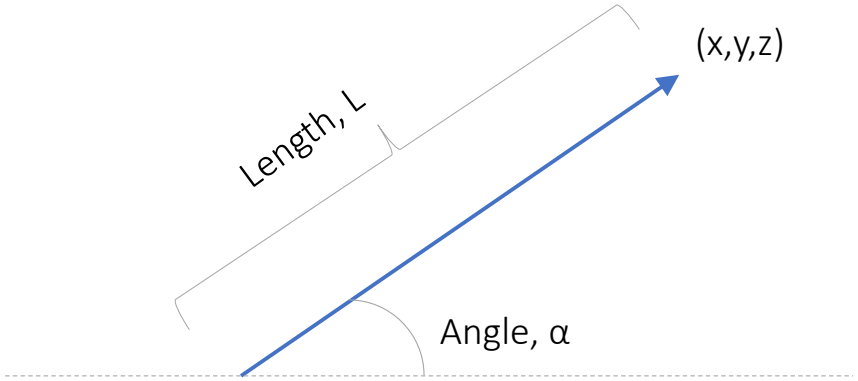


NURBS – E.g. Rhino

Mesh modelling - E.g. Maya

Vectors

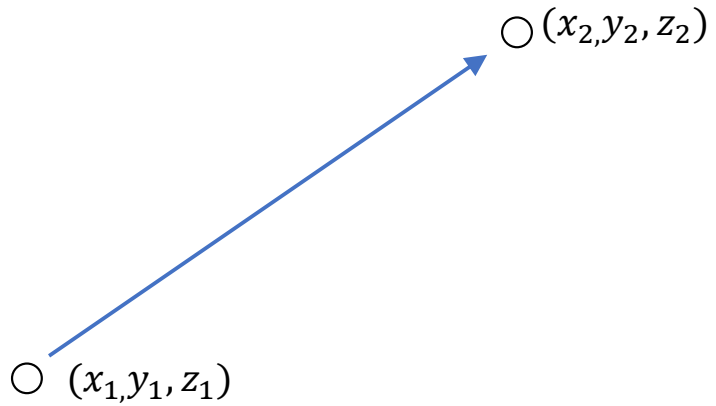
- Length
- Direction
- Described as (x,y,z)



https://www.matteboken.se/lektioner/matte-1/geometri/rakna-med-vektorer

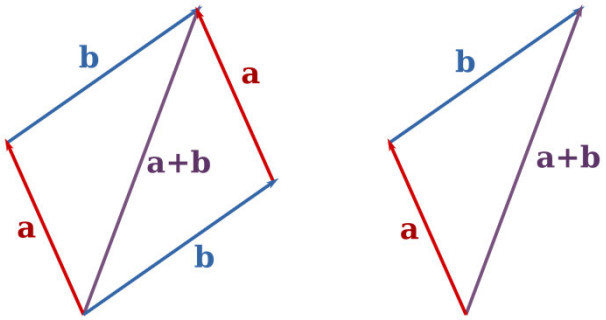
Vectors

- Length
- Direction
- Described as (x,y,z)
- Most common way
  to compute: $(x_2, y_2, z_2) - (x_1, y_1, z_1)$



https://www.matteboken.se/lektioner/matte-1/geometri/rakna-med-vektorer

Vector operations



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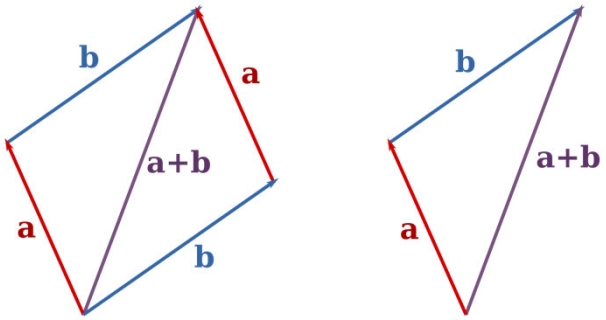
Vector Addition

Vector a + Vector b

https://en.wikipedia.org/wiki/Euclidean_vector

https://www.matteboken.se/lektioner/matte-1/geometri/rakna-med-vektorer

Vector operations



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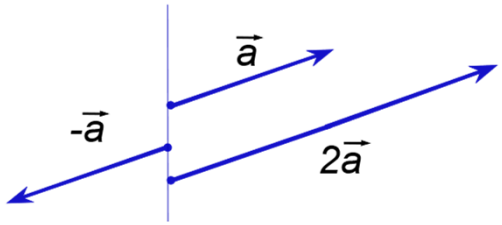

Image By Silly rabbit CC BY-SA 3.0,
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Vector Addition

Vector a + Vector b

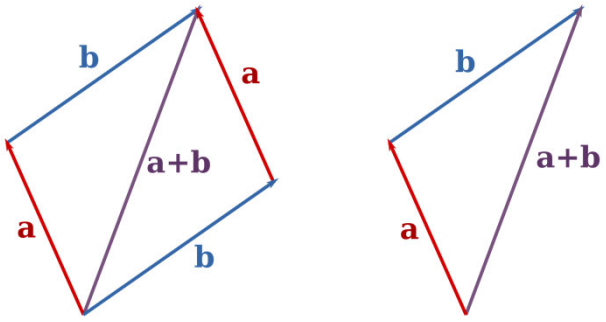
Scalar multiplication

Vector a · number

https://en.wikipedia.org/wiki/Euclidean_vector

https://www.matteboken.se/lektioner/matte-1/geometri/rakna-med-vektorer

Vector operations



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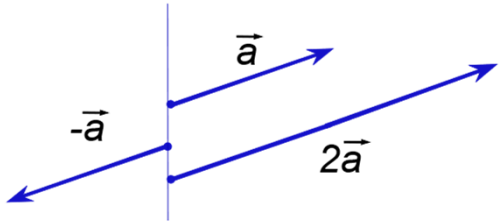
Vector Addition

Vector a + Vector b



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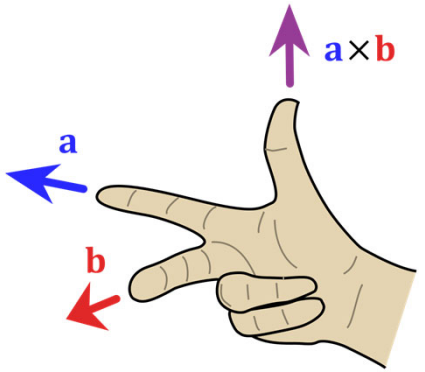
https://commons.wikimedia.org/w/index.php?curid=5088002

Scalar multiplication

Vector a · number



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https://commons.wikimedia.org/w/index.php?curid=4436743

Cross product(new)

Vector a x Vector b

https://en.wikipedia.org/wiki/Euclidean_vector

https://www.matteboken.se/lektioner/matte-1/geometri/rakna-med-vektorer